WHAT IS CLAIMED IS:

1. A magnetic recording medium comprising a nonmagnetic substrate, a first magnetic recording layer formed on the nonmagnetic substrate, and a second magnetic recording layer formed on the first magnetic recording layer, wherein the first and second magnetic recording layers interact each other to make the magnetization directions thereof antiparallel, and the axis of easy magnetization in each of the first and second magnetic recording layers is perpendicular to the plane of the layers.

2. A medium according to claim 1, further comprising a soft magnetic layer between the nonmagnetic substrate and first magnetic recording layer.

3. A medium according to claim 1, wherein when a magnetic field is applied perpendicularly to the plane of the magnetic recording layer until magnetization saturated in one direction is reversed and saturated in the opposite direction, the sign of the magnetic field upon reversal in the first magnetic recording layer is different from that in the second magnetic recording layer.

4. A medium according to claim 1, wherein the antiferromagnetic exchange coupling energy density during the interaction is not less than 0.01 erg/cm^2.

5. A medium according to claim 1, wherein the

second magnetic recording layer contains magnetic grains, and a nonmagnetic material present between the magnetic grains.

6. A medium according to claim 1, wherein at least one of the first and second magnetic recording layers has a multilayered structure in which a ferromagnetic layer containing Co in larger amount and a nonmagnetic layer containing one of Pd and Pt in larger amount are alternately stacked.

7. A medium according to claim 1, further comprising not less than one interlayer selected from interlayers M1 to M5 between the first and second magnetic recording layers,

wherein the combination of layers is selected from

first magnetic recording layer/M1/second magnetic recording layer,

first magnetic recording layer/M2/M1/second magnetic recording layer, first magnetic recording layer/M4/M2/M1/second magnetic recording layer,

first magnetic recording layer/M2/M1/M3/second magnetic recording layer, first magnetic recording layer/M4/M2/M1/M3/second magnetic recording layer,

first magnetic recording layer/M2/M1/M3/M5/second magnetic recording layer, first magnetic recording layer/M4/M2/M1/M3/M5/second magnetic recording layer,

first magnetic recording layer/M1/M3/second magnetic recording layer, and first magnetic recording

layer/M1/M3/M5/second magnetic recording layer,

the interlayer M1 substantially consists of a nonmagnetic material having a thickness of not more than 2 nm, and not less than two of the first magnetic recording layer, interlayers M2 and M3, and second magnetic recording layer are coupled by antimagnetic exchange coupling.

8. A medium according to claim 7, wherein the interlayer M1 contains one of a semiconductor and a magnetic material-doped semiconductor.

9. A medium according to claim 7, wherein the interlayer M1 mainly contains at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, and Al.

10. A medium according to claim 9, wherein the interlayer M1 mainly contains at least one material selected from the group consisting of Ru, Rh, and Ir.

11. A medium according to claim 7, wherein the interlayer M2 substantially consists of a Co-based alloy.

12. A medium according to claim 7, wherein the interlayer M3 substantially consists of a Co-based alloy.

13. A medium according to claim 7, wherein the interlayer M4 mainly contains at least one material selected from the group consisting of at least Ru, Re,

Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor.

14. A medium according to claim 7, wherein the interlayer M4 is represented by formula M-G wherein M is selected from the group consisting of Si, Al, Zn, Sn, In, Zr, Co, Fe, and B, and G is selected from the group consisting of O, N, C, and H.

15. A medium according to claim 8, wherein the interlayer M5 contains at least one material in larger amount, selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor.

16. A medium according to claim 7, wherein the interlayer M5 is represented by formula M-G wherein M is selected from the group consisting of Si, Al, Zn, Sn, In, Zr, Co, Fe, and B, and G is selected from the group consisting of O, N, C, and H.

17. A medium according to claim 1, further comprising not less than three interlayers selected from interlayers M1 to M7 between the first and second magnetic recording layers,

wherein the combination of layers is selected from

first magnetic recording layer/M6/M4/M1/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/second

magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M3/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M3/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M2/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M3/M5/M7/second magnetic recording layer, and

first magnetic recording layer/M4/M2/M1/M3/M5/M7/second magnetic recording layer,

the interlayer M1 substantially consists of a nonmagnetic material having a thickness of not more than 2 nm, not less than two of the first magnetic recording layer, interlayers M2 and M3, and second magnetic recording layer are coupled by antimagnetic exchange coupling, and the interlayers M6 and M7 contain at least one material selected from the group consisting of Pt, Pd, Ru, and Re.

18. A medium according to claim 17, wherein the interlayer M1 contains one of a semiconductor and a magnetic material-doped semiconductor.

19. A medium according to claim 17, wherein the interlayer M1 mainly contains at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, and Al.

20. A medium according to claim 19, wherein the interlayer M1 contains at least one material in larger amount, selected from the group consisting of Ru, Rh, and Ir.

21. A medium according to claim 17, wherein the interlayer M2 substantially consists of a Co-based alloy.

22. A medium according to claim 17, wherein the interlayer M3 substantially consists of a Co-based alloy.

23. A medium according to claim 17, wherein the interlayer M4 mainly contains at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor.

24. A medium according to claim 17, wherein the interlayer M4 is represented by formula M-G wherein M is one member selected from the group consisting of Si, Al, Zn, Sn, In, Zr, Co, Fe, and B, and G is one member selected from the group consisting of O, N, C, and H.

25. A medium according to claim 17, wherein the

interlayer M5 mainly contains at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor.

26. A medium according to claim 17, wherein the interlayer M5 is represented by formula M-G wherein M is one member selected from the group consisting of Si, Al, Zn, Sn, In, Zr, Co, Fe, and B, and G is one member selected from the group consisting of O, N, C, and H.

27. A medium according to claim 1, wherein not less than three first and second magnetic recording layers are alternately stacked.

28. A magnetic recording medium comprising a nonmagnetic substrate, a first magnetic recording layer formed on the nonmagnetic substrate, and a second magnetic recording layer formed on the first magnetic recording layer, wherein the first and second magnetic recording layers interact each other to make the magnetization directions thereof antiparallel, the axis of easy magnetization in each of the first and second magnetic recording layers is parallel to the plane of the layer,

the magnetic recording medium further comprises not less than three interlayers selected from interlayers M1 to M7 between the first and second magnetic recording layers, the combination of layers is

selected from

first recording layer/M4/M2/M1/second recording layer, first recording layer/M6/M4/M2/M1/second recording layer,

first recording layer/M4/M2/M1/M3/second recording layer, first recording layer/M6/M4/M2/M1/M3/second recording layer,

first recording layer/M2/M1/M3/M5/second recording layer, first recording layer/M4/M2/M1/M3/M5/second recording layer, first recording layer/M6/M4/M2/M1/M3/M5/second recording layer,

first recording layer/M2/M1/M3/M5/M7/second recording layer, first recording layer/M4/M2/M1/M3/M5/M7/second recording layer, first recording layer/M6/M4/M2/M1/M3/M5/M7/second recording layer,

first recording layer/M1/M3/M5/second recording layer, and first recording layer/M1/M3/M5/M7/second recording layer,

first magnetic recording layer/M6/M4/M1/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M3/M5/M7/second magnetic recording layer, and

first magnetic recording layer/M4/M2/M1/M3/M5/M7/second magnetic recording layer,

the interlayer M1 mainly contains at least one material selected from the group consisting of Ru, Rh, Re, and Ir, the interlayers M2 and M3 are made of a

material containing an alloy which consists primarily of Co, the interlayers M4 and M5 mainly contain at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor, the interlayers M6 and M7 contain at least one material selected from the group consisting of Pt, Pd, Ru, and Re, each of the interlayers M1, M2, M3, M4, and M5 has a thickness of not more than 2 nm, and at least two of the first magnetic recording layer, interlayers M2 and M3, and second magnetic recording layer have antiferromagnetic exchange coupling.

29. A medium according to claim 28, wherein not less than three first and second magnetic recording layers are alternately stacked.

30. A magnetic recording/reproducing apparatus comprising:

a magnetic recording medium having a nonmagnetic substrate, a first magnetic recording layer formed on the nonmagnetic substrate, and a second magnetic recording layer formed on the first magnetic recording layer, the first and second magnetic recording layers interacting each other to make the magnetization directions thereof antiparallel, and the axis of easy magnetization in each of the first and second magnetic recording layers being perpendicular to the plane of

the layer;

a driving mechanism which supports and rotates the magnetic recording medium; and

a mechanism which applies a recording magnetic field to the recording magnetic medium.

31. An apparatus according to claim 30, further comprising an auxiliary head which applies a magnetic field smaller than the recording magnetic field to the magnetic recording medium.

32. A magnetic recording/reproducing apparatus comprising:

a magnetic recording medium having a nonmagnetic substrate, a first magnetic recording layer formed on the nonmagnetic substrate, and a second magnetic recording layer formed on the first magnetic recording layer,

a driving mechanism which supports and rotates the magnetic recording medium; and

a mechanism which applies a recording magnetic field to the recording magnetic medium,

wherein the first and second magnetic recording layers interact each other to make the magnetization directions thereof antiparallel, the axis of easy magnetization in each of the first and second magnetic recording layers is parallel to the plane of the layer,

the magnetic recording medium further comprises not less than three interlayers selected from

interlayers M1 to M7 between the first and second magnetic recording layers, the combination of layers is selected from

first recording layer/M4/M2/M1/second recording layer, first recording layer/M6/M4/M2/M1/second recording layer,

first recording layer/M4/M2/M1/M3/second recording layer, first recording layer/M6/M4/M2/M1/M3/second recording layer,

first recording layer/M2/M1/M3/M5/second recording layer, first recording layer/M4/M2/M1/M3/M5/second recording layer, first recording layer/M6/M4/M2/M1/M3/M5/second recording layer,

first recording layer/M2/M1/M3/M5/M7/second recording layer, first recording layer/M4/M2/M1/M3/M5/M7/second recording layer, first recording layer/M6/M4/M2/M1/M3/M5/M7/second recording layer,

first recording layer/M1/M3/M5/second recording layer, and first recording layer/M1/M3/M5/M7/second recording layer,

first magnetic recording layer/M6/M4/M1/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M1/M3/M5/M7/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/second magnetic recording layer,

first magnetic recording layer/M6/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M2/M1/M5/M7/second magnetic recording layer,

first magnetic recording layer/M4/M1/M3/M5/M7/second magnetic recording layer, and

first magnetic recording layer/M4/M2/M1/M3/M5/M7/second magnetic recording layer,

the interlayer M1 mainly contains at least one

material selected from the group consisting of Ru, Rh, Re, and Ir, the interlayers M2 and M3 are made of a material containing an alloy which consists primarily of Co, the interlayers M4 and M5 mainly contain at least one material selected from the group consisting of at least Ru, Re, Rh, Ir, Tc, Au, Ag, Cu, Si, Fe, Ni, Pt, Pd, Cr, Mn, Al, a semiconductor, and a magnetic material-doped semiconductor, the interlayers M6 and M7 contain at least one material selected from the group consisting of Pt, Pd, Ru, and Re, each of the interlayers M1, M2, M3, M4, and M5 has a thickness of not more than 2 nm, and at least two of the first magnetic recording layer, interlayers M2 and M3, and second magnetic recording layer have antiferromagnetic exchange coupling.